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FOR

ROAD AND TRAIL

MAINTENANCE



(CSO Supplement to BLM Manual Section 9113)

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ROAD AND TRAIL MAINTENANCE HANDBOOK

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INTRODUCTION

This Handbook is intended to provide general criteria for performance of road and trail maintenance work in Colorado. The maintenance criteria presented describes the way a Bureau road or trail should look or function as a result of the maintenance efforts. The maintenance levels described in this Handbook provide guidelines to Bureau personnel in their efforts to establish consistent levels of maintenance throughout the State. These levels are also intended as goals of accomplishment; however, because of budgetary and/or manpower constraints, all of these goals may not be immediately achieved. Priorities are, therefore, established to assist in determining which activities will be performed at any time when conflicts prevent the accomplishment of all planned work. Implementation of maintenance levels which promote safety will always have priority over levels which are concerned with improving the appearance of the roadway or providing convenience to the public.

This Handbook is not intended to, nor does it, establish a legal standard of care.

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GENERAL

SCOPE: This Handbook has been developed to aid in the planning of the road and trail maintenance activity based upon and directed toward implementation of these levels, unless otherwise directed.

MAINTENANCE OBJECTIVES: It is the Bureau's objective that its roads and facilities be maintained in such a manner as to:

- Provide safety for both the general public and Bureau personnel,
- Protect the Bureau's investment in the total roadway facility,
- Promote efficiency and economy in maintenance operations within budget restraints, and
- Provide convenience, promote aesthetics where practical, and otherwise promote the Bureau welfare.

MAINTENANCE PRIORITIES: Conditions which might be considered hazardous to the safety of the general public and Bureau personnel shall be corrected before other maintenance work is performed. Other factors are cited indicating their relative priority to safety. It must be recognized that any condition may have several implications and that priority will vary as the combinations of these implications are considered. As an example of such a condition ---- a break in a surfaced roadway, such as a large pothole, must be considered as:

- Potentially hazardous in that it might cause a driver to lose control of his vehicle, and
- Endangering the physical structure of the roadway in that impact of traffic will expand damage to the surface and allow access of moisture to the base and its subsequent deterioration.

It must also be recognized that the criticalness of a condition varies with the usage of the roadway. Conditions which may be potentially hazardous on a high volume, high speed roadway may be tolerable on low

volume, low speed roads and have a low priority for repair. The condition could be more serious on a low speed road before it would require maintenance.

Where possible, levels defined in this Handbook will reflect priorities associated with specific conditions or combinations of conditions. Maintenance personnel will, however, be required to exercise judgment in the establishment of work priorities as no Handbook of this type could possibly define all of the various considerations in a work priority decision. As a basis for such judgment, priority rankings for performance of certain types of maintenance or repair in response to various types of roadway facilities and conditions are offered below.

When faced with a decision as to which of several maintenance jobs might have precedence and assuming that no immediate safety hazard is involved, priorities must be established balancing the following characteristics:

- Extent of potential economic loss if the road does not receive immediate repair or maintenance,
- Extent of inconvenience judged by the usage of the road and the severity of the condition, and
- Whether repairs must be extensive and permanent, or if temporary repairs would be suitable.

When attempting to schedule routine maintenance activities which are intended to correct known problems or conditions, consideration should be given as to what part of the total roadway or trail area requires attention e.g., surface, shoulders, base, roadside, tread, corduroy, etc. The same factors mentioned above must be considered before a decision is made. Certain roads and trails represent a greater investment or economic value to the Bureau than do others and therefore should receive greater maintenance efforts.

MAINTENANCE PRIORITIES

FACILITY OR CONDITION	POTENTIAL SAFETY HAZARD	POTENTIAL ECONOMIC LOSS
-----------------------	-------------------------	-------------------------

Surfaced Roadway Maintenance

*Surface	First	First
*Dikes or Berms	Second	Third
*Base and Shoulders	First	First
Slippery Pavement	First	Third
Potholes	First	Second
Shoulder Dropoff	First	Second
Loose Material on Road	First	Third
Snow or Ice on Road	First	Second
Base Failure	First	Second
Wheel Grooving	First	Second
Pavement Bleeding	Second	Second
Water Ponding	Second	Third
Corrugations	First	Third
Settlement, Heave and Distortion	First	Second
Raveling	Second	Second
Cracking	Second	Third
Untreated Shoulder Irregularities	Second	Second

Unsurfaced Roadway Maintenance

*Surface	First	Second
*Base and Shoulders	First	Second
Outside normal traveled way on some unsurfaced roads, there is no distinction between the base and shoulders when they consist of the same material.		
*Berms	Second	Third
Corrugations	First	Third
Potholes	First	Third

*Facility

MAINTENANCE PRIORITIES (cont.)

FACILITY OR CONDITION	POTENTIAL SAFETY HAZARD	POTENTIAL ECONOMIC LOSS
Snow on Road	First	Second
Excessive Loose Material on Road	Second	Third
Wheel Grooving	Second	Third
Water Ponding	Second	Second
Base Failure	First	First
Settlement	Second	Third
Shoulder Irregularities	Second	Third
Drainage Structure Maintenance		
*Culverts	First	First
*Ditches	First	Second
*Drains	Second	Second
*Gutters	Second	Third
*Debris Barriers	Third	Third
Roadside Maintenance		
*Bench	First	First
*Retaining Walls and Cribs	First	First
*Cattle Guard	First	Second
*Vegetation	Second	Third
*Fence	Third	Third
Traffic Services and Operations Maintenance		
*Signs	First	Third
*Guard Rails and Guide Posts	First	Second
*Pavement Markings	Second	Third
*Maintenance Buildings, Tools and Equipment	First	First
*Facility		

Undesirable Conditions Affecting Drainage

These conditions should be routinely corrected as required:

Drainage structures too large or too small
Crossdrain too flat
Berms improperly located
Inadequate head room
Improper type of drop inlet
Improper placement of drop inlet
Cut slopes too steep
Gutters too flat These conditions should
No downdrains where necessary
Outlet channels inadequate required
Gutters too narrow and too steep
Cut slopes too flat
Downdrain too short
Crossdrains placed too shallow
Crossdrains placed too deep
Inadequate crown
Grade too flat
Grade too steep
Roadway elevation too low
Inadequate entrance to drop Inlet or culvert

ROAD AND TRAIL MAINTENANCE HANDBOOK

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PREMIX PATCHING

DESCRIPTION:

Patching potholes and severe depressions in a bituminous road surface with hot or cold premixed bituminous materials.

PURPOSE:

To restore a smooth riding surface by repairing potholes, breaks and severe settlements that are a traffic hazard or that will result in further and more rapid deterioration.

PROCEDURES:

1. Broom area to be patched.
2. In the case of potholes, remove loose or broken material with shovel, pick or other means to square up sides of area to be repaired. Extend broken area into solid surface.
3. Make certain interior of hole to be repaired, after cleaning and squaring up, is dry. Heat with torch or burner if necessary.
4. Apply asphalt tack coat to area to be patched. If hand shot, area should only have bubble appearance; if broom or pour-pot is used, a spider web appearance should be in area of patch.
5. Place premix with shovels or dump from truck if area is large enough and level premix with shovels and rakes.
6. Each layer of premix must not exceed two inches in depth and should be hand tamped or rolled.
7. On final course, roll the patch after the material has cooled enough so that it will not be picked up by the tamper or roller.
8. Check patch with straight edge to make sure it is level with the surrounding surface (no bumps, no depressions) and correct if necessary.

SPOT SURFACE REPLACEMENT - AREAS LARGER THAN POTHOLEs

DESCRIPTION:

Removal of deteriorated surface or shoulder material that is broken, cracked through and heaved over an area large enough to use heavy construction equipment for repair work to be done.

PURPOSE:

To provide a smooth, strong, unbroken riding surface to an area where the existing pavement has deteriorated so badly that it cannot be salvaged by smaller patching.

PROCEDURES:

1. Remove surface material with motor patrol, gradall, air hammers or other means, squaring up the area to be patched.
2. Check base and re-compact material loosened by removal of surfacing.
3. Prime or tack area with asphalt.
4. Spot dump premix from trucks and spread in layers. Each layer of Premix must not exceed two inches in depth. Roll or tamp each layer.
5. Final layer of premix should be leveled slightly higher than surrounding area with motor patrol.
6. Roll the area when material has cooled enough so that it will not be picked up by the roller.
7. Check completed patch with straight edge and correct if necessary.

SURFACE TREATMENT PATCHING

DESCRIPTION:

Patching Bituminous Roadway or other paved surface with one or more applications of hot asphalt and aggregate.

PURPOSE:

To seal small areas and prevent surface deterioration from cracking or raveling.

PROCEDURES:

1. Broom area to be patched.
2. Adjust width of spray bar and shoot asphalt in a rectangular area at least six inches beyond deteriorated area. Small area patches will be shot with hand hose. If hand hose is used it should be held about 18" above the surface and moved rapidly using a side-to-side motion. Application should be 0.1 to 0.25 gallons per square yard.
3. Spread aggregate uniformly over the asphalt, using choke board on tailgate spreaders if there is no other way to reduce spread width.
4. Roll the patch, overlapping each pass, until the entire patch has been rolled.
5. If more than one application is used, only the last application need be squared up. The first layer of aggregate may be more coarse than the second course.
6. Broom excess aggregates from travelway.

TEMPORARY OR EMERGENCY POTHOLE PATCHING

DESCRIPTION:

Patching or filling of potholes with use of granular materials during periods of bad weather when bituminous materials cannot be effectively used. Materials should be less than 1" in size.

PURPOSE:

To provide a smooth riding surface and to attempt to reduce pothole from becoming larger. This work is usually done during only very cold or wet weather with Premix Patching to be accomplished when weather permits.

PROCEDURES:

1. Place materials in hole with shovel.
2. Roll with truck tires.
3. Remove excess, do not leave a bump.

PREMIX LEVELING

DESCRIPTION:

Major leveling of surface irregularities with bituminous premix material just prior to placing a seal coat.

PURPOSE:

To restore the roadway surface to its original cross-section in order to have a smooth, level and strong surface on which to place a seal coat.

PROCEDURES:

1. Fill and patch all potholes, all cracks over 3/16" wide, severe depressions and/or perform base repairs, if necessary.
2. Broom the surface of loose materials.
3. Place light asphalt tack on these areas to be leveled.
4. Spread premix with motor patrol or spreader. Make sure the surface is level and feather the edges smoothly with exposed existing pavement.
5. Roll the premix material when it has cooled enough so that it will not be picked up by the roller.
6. Check leveled areas with a straight edge or stringline and make corrections if necessary.

SEAL COATING

DESCRIPTION:

Retreatment of full surface width on continuous sections of bituminous pavement with one or more applications of bituminous materials and aggregate (single seal, double seal, etc.) Approach aprons should be sealed when sealing roadway.

PURPOSE:

To seal the surface against water penetration and to restore surface life, increase skid resistance and flexibility in order to prevent further deterioration from raveling and cracking.

PROCEDURES:

1. Since this type of surface treatment is usually less than an inch in thickness, it is not intended in itself to increase the strength of the base. Make all necessary surface and base repairs, fill all cracks over 3/16" in width and do all work necessary to preserve roadway prior to start of seal coating.
2. Broom surface of entire section or pavement to be seal coated and clear grass from edges. Do not broom too far ahead of application of seal as rebrooming will possibly be required due to traffic.
3. Application of asphalt should be 0.1 to 0.25 gallons per square yard.
4. Spread aggregate uniformly over the asphalt surface. Apply only the predetermined amount of aggregate.
5. Hand broom aggregate where necessary to make sure all asphalt is covered.
6. Roll full width of paved surface letting the roller overlap previous passes with each succeeding pass. Both pneumatic tire and steel-wheel rollers may be used.
7. If needed, drag broom to level out any excess aggregate and roll again.

8. It may be necessary to hand broom excess cover aggregate from the roadway where spillage or overlapping of spread occurs.
9. After completion of surface treatment, traffic should be controlled until curing has occurred. Curing takes place best when the air temperature is well above 50° F and the relative humidity is low.

LIMITATIONS:

1. Weather conditions must be favorable to secure a good job.
2. The surface on which the asphalt is sprayed must be hard, clean and dry for the surface treatment to adhere properly.
3. The amount and viscosity of the asphalt must be carefully balanced with the size and amount of cover aggregate to insure proper retention of the aggregate.
4. Heavy, high speed traffic tends to dislodge the aggregate from the asphalt and "whip it off" the traveled way.

CRACK REPAIR

DESCRIPTION:

Cleaning, filling and sealing cracks in bituminous surfaces and minor surface patching of spalled areas.

PURPOSE:

To prevent surface moisture from passing into base or subgrade causing failures, and to prevent further spalling along the edge of cracks.

PROCEDURES:

1. Select only those cracks which are at least 3/16" wide.
2. Clean cracks with compressed air. If there are spalled areas along the cracks, the loosened edge of material should be removed.
3. Fill cracks by one of these methods: In cleaned cracks, special crack-filling asphalt can be poured; or a slurry seal application can be made by holding a squeegee tight against the pavement so that the slurry runs into the cracks; or fill the cracks by brooming a lean sand-asphalt mixture into the cracks until they are full. In the latter method, an RC-0 or RC-1 liquid asphalt should be poured on the filled cracks with sufficient quantity to seal the top of the sand mix and tie to the edges of the cracks.
4. Sprinkle lightly with sand when needed to blot up excess asphalt.

NOTE: This work is to repair reflection cracks only. Dense pattern cracking (alligator cracks) should be repaired by surface treatment patching.

EDGE RUT REPAIR - PAVED SURFACE

DESCRIPTION:

Edge ruts should be corrected under this operation anytime the conditions persist over an area too long for hand work and when the drop off is about 2" or more. Material should be added in a continuous wedge shape and rolled into place to prevent edge breaking.

PURPOSE:

Edge breaking is usually caused by lack of lateral support by earth shoulders. It may also be caused by excessive moisture or drying along the pavement edge. To bring shoulder up even with surface edge, or to bring up to an overlay done on the surface. The shoulder should be improved so as to provide adequate lateral support to the pavement edge.

PROCEDURES:

1. Dump material along work area using divider device in dump bed.
2. Blade and smooth material to original or built up surface edge grade and slope.
3. Compact material by rolling with truck tires or roller. Add moisture if necessary.
4. Broom loose materials from surface or roadway.

BASE FAILURE

DESCRIPTION:

Repair of base and/or subgrade failures under bituminous pavements, aggregate surfacing and failures in earth surface roadbeds, by the excavation of unsatisfactory materials and replacement with aggregate or other suitable materials.

PURPOSE:

To repair surface failures caused by faulty base or subgrade and to prevent further settlement and breaking of the surface by building a strong foundation for the surface.

PROCEDURES:

1. Cut out surface with gradual, backhoe, loader or other suitable equipment.
2. Remove unsatisfactory base or subgrade materials, avoiding costly hand labor as much as possible.
3. Dispose of unsatisfactory materials at a predetermined area away from view of the traveling public.
4. If it looks like water in the subgrade is the cause for failure, install underdrain pipes or a french drain system to drain excess water out through the shoulder into the drainage ditch.
5. Place new base materials in 6" to 8" layers in cut out sections, roll, tamp by hand or use vibra-tampers to obtain sufficient compaction.
6. The final layer of new material should be compacted level with surrounding base.
7. Replace surfacing as described by Premix Patching, or Gravel Replacement, see FP-79 for special instructions for cement stabilized base.
8. Broom loose materials from asphalt surface before patching surface.

LIGHT MACHINE DITCH CLEANING - PAVED, GRAVELED AND EARTH ROADS

DESCRIPTION:

Smoothing and shaping of ditches with motor grader to provide proper flow in the ditch line. No materials to be loaded or hauled.

PURPOSE:

To keep ditches in good operating condition by restoring the Original line, grade, or bottom cross-section.

PROCEDURES:

1. Make sufficient passes to shape and dress foreslope of ditches.
2. Make sufficient passes to shape and dress backslope of ditches.

Note: Refer to Motor Patrol Operation Section of this Handbook

CLEAN AND REPAIR DRAINAGE STRUCTURES - PAVED, GRAVEL AND EARTH ROADS

DESCRIPTION:

Cleaning, repairing and replacement of catch basins, drop inlets, trash racks, pipe culverts and other drainage structures, paved ditches and hand work in connection with cleaning inlet and outlet ditches.

PURPOSE:

To keep drainage structures in good operating condition, free of all debris or other obstructions which will impair or impede the flow.

PROCEDURES:

CATCH BASINS

1. Remove debris and trash from around grates and load into truck for disposal.
2. Remove sediment deposited in catch basin and load into truck for disposal.
3. Correct scour around catch basin with sod or riprap.
4. Repair or replace damaged grates.

PIPE CULVERTS

1. Remove debris and sediment from inside of culvert and load into truck.
2. Remove debris or undesirable vegetation from inlet and outlet channels and load into truck.
3. Correct scour around culvert with sod, riprap, A.C. pavement or concrete.
4. Repair or replace culverts that have settled, been pushed out of line, or are badly eroded.

PAVED DITCHES

1. Remove trash and undesirable vegetation from paved ditches and load into truck for disposal.
2. Seal breaks and cracks with appropriate materials.

UNDERDRAINS

1. Remove trash, silt and undesirable vegetation from outlet, use high pressure water pumps and attempt to flush out all silt and sediment if a free flow of water is not indicated.
2. Repair or replace damaged underdrain pipes.

OTHER DRAINAGE STRUCTURES

1. Remove debris and trash from structure.
2. Remove sediment, silt and vegetation from inlet and outlet channels.
3. Repair or replace damaged structures or sections as needed.

SPOT PATCHING SURFACE AGGREGATE OR EARTH ROADS

DESCRIPTION:

Patching non-paved roadway surfaces with aggregates of correct gradation to repair soft spots and surface irregularities (includes shaping).

PURPOSE:

To provide a smooth riding surface and maintain the proper crown.

PROCEDURES:

1. Make one pass with the motor patrol to remove high spots.
2. Spot dump additional material in low areas or at selected intervals. (Patching with granular material will work when there is adequate soil, but if there is enough rock, no more should be added. This condition should be corrected by reshaping and getting a better blend of soil and rock).
3. Make sufficient passes with the motor patrol so that material is spread evenly and shaped to proper crown of 1/4 to 1/2 inch per foot. Add moisture if necessary. Roll or compact with equipment as needed.

NOTE: Remember that a gravel road depends on a balance of gravel and soil binder. There is no need to add gravel if there is already loose material on the surface.

GRADING SURFACE OF AGGREGATE OR DIRT ROADS

DESCRIPTION:

Blading or dragging of non-paved surfaces to smooth and reshape the riding surface. (No material added.)

PURPOSE:

To keep non-paved surfaces in proper condition by cutting down high spots, filling low spots, and maintaining proper crown.

PROCEDURES:

1. Blade or drag surface material from road edges toward center of road. (There are basically two operations done under this procedure. In dry weather, tilt the blade forward (mold board) and pull loose material into place; when moisture is available in the surface, tilt the blade back and cut and re-mix material as it is bladed into place.) Lean or slightly tilt front wheels about 10 $\frac{1}{2}$ to 15 $\frac{1}{2}$ from the vertical in direction aggregate rolls across blade.
2. Make additional passes drawing loosened material back again into hollow areas. Corrugations in excess of 1" should not be permitted. Large rock, loose surface materials and windrows over 4" should be removed.
3. Make sufficient passes to achieve the proper crown. Crown should be established at 3/4" per foot on flat grade and 1/4" to 1/2" per foot on rolling, hilly or mountainous country. A rooftop crown shall be used.
4. Periodically, blade surface of the road against the flow of traffic to eliminate drifting of aggregate onto ends of bridges, cattleguards, intersections, and railroad crossings.
5. Stop to repair minor bad spots, such as holes, rutted areas, and poor surface drainage conditions. Always have a hand shovel available.

GRADING GRAVEL, EARTH OR TURF SHOULDERS - PAVED ROAD SURFACE

DESCRIPTION:

Grade shoulders to bring material up against the edge of the pavement and include the spot addition of material when needed to replace lost material. Grass and vegetation build up over 1" should not be permitted.

PURPOSE:

To maintain a smooth shoulder that will drain away surface water and will provide a safe emergency driving or stopping surface for traffic.

PROCEDURES:

1. Make one pass with the motor patrol to cut off high spots and to pull material against edge of roadway.
2. Spot dump additional material in low areas or at intervals along the shoulder. Slope of the shoulder should not be less than 3/4" per foot nor over 1-1/2" per foot, depending on the texture of the surface and roadway grade. When more than spot addition of material is needed to bring the shoulder up against the edge of the pavement, EDGE RUT REPAIR should be performed.
3. Make sufficient passes with the motor patrol so that material is level with pavement edge and shaped to drain properly.
4. If necessary, add moisture and compact shoulder material with truck or roller.
5. Broom excess materials from roadway surface.

RECONDITION GRAVEL AND EARTH ROADS

DESCRIPTION:

Reconditioning shall be done only when there is a general loss of gravel surfacing, a change in general condition of gravel or earth surface which results in breaks in the crust or a change of surface composition.

PURPOSE:

To restore the cross-section of the road and replace gravel surface; to obtain correct compaction, cut backslopes, clean ditches and shape foreslopes. To haul material away from ditches if contamination of gravel surface would occur.

PROCEDURES:

GRAVEL ROAD

1. All culvert pipes should be cleaned and/or replaced as needed.
2. Scarify gravel surfacing and windrow to side opposite ditch being reshaped to prevent contaminating aggregates.
3. Reshape ditch, backslope and foreslope using ditch materials to bring up sub-grade unless materials from ditch are unsatisfactory for sub-grade; if unsatisfactory, then it should be windrowed and removed and disposed of.
4. After completing step 3 then move salvaged materials from step 2 to side completed and proceed with step 3 on the other side of roadway.
5. Upon completion of step 3 on both sides of roadway, replace aggregate and add more gravel as necessary to provide an all weather surface.
6. After grading, clean inlet basins of culvert pipes.

EARTH ROAD

1. Clean all culvert pipes and/or replace as needed.
2. Reshape ditch, backslope and foreslope, using ditch materials to bring up sub-grade and grade, unless materials are unsatisfactory. Unsatisfactory materials should be removed and replaced with satisfactory material to return roadway to or slightly above original grade-line.
3. After grading, clean inlet basins of culvert pipe.

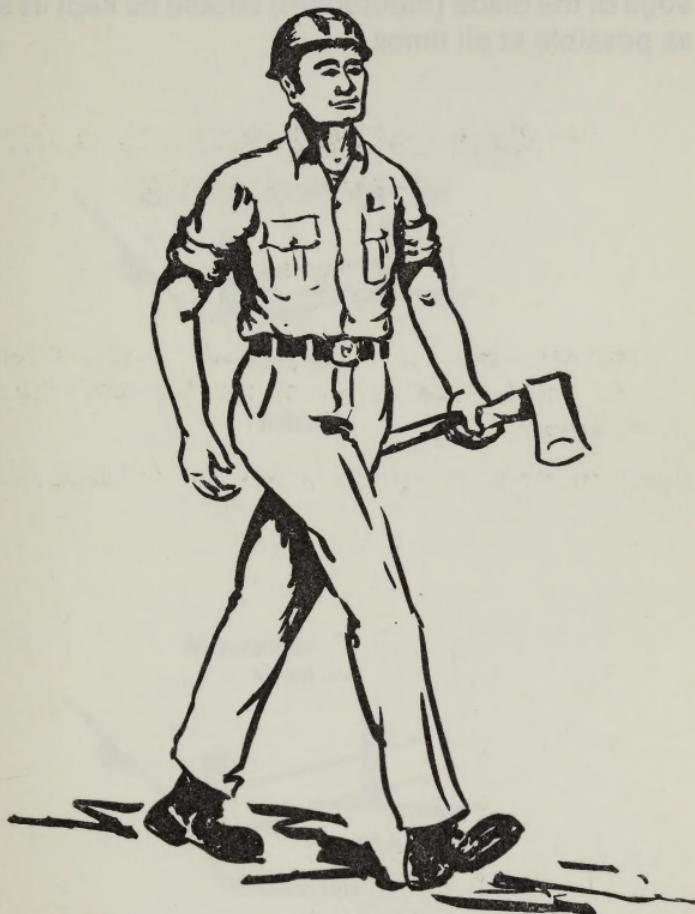
RECONDITION GRAVEL AND EARTH ROADS

GENERAL

1. After reshaping surface and providing proper crown, bring surface to optimum moisture with water truck if needed.
2. Roll surface with pneumatic roller or loaded trucks.

MOTOR PATROL OPERATION

Most maintenance activities involving the use of motor patrols are ditching and blading operations. The improper use of a motor patrol may cause future problems which can be easily avoided. The following examples point out some of the problems caused by the improper use of motor patrols and give methods of operation to avoid future trouble:



DRIVE AT WALKING SPEED

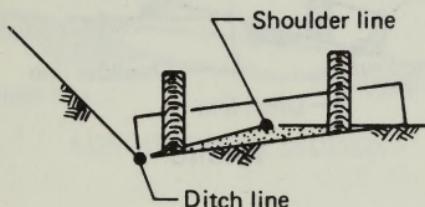
An important point to cover first is SPEED. Too much speed will cause the motor patrol to bounce and dig up the road or ditch instead of smoothing it out. Too much speed may also cause the operator to lose control of the machine which could result in an accident or the creation of a hazard to the public.

A good speed for ditching or blading should never be more than walking speed and in some cases it should be slower. Speed will depend on the particular road and the condition of the road surface. The cutting edge of the blade (moldboard) should be kept as sharp as possible at all times.

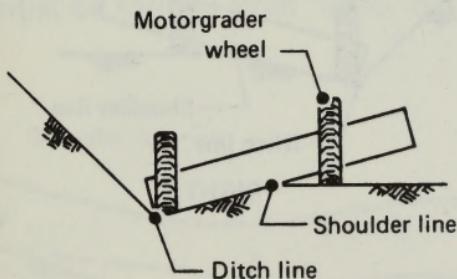
DITCHING WITH A MOTOR PATROL CAN CAUSE THREE MAJOR PROBLEMS:

1. Reduced shoulder width is caused by placing the blade at an incorrect angle or dips in the ditch or shoulder.

The best solution is to place the blade along the foreslope from the shoulder line to the ditch line. The operator must watch the shoulder and ditch lines and where they dip or the slope increases, the heel of the blade should be raised.



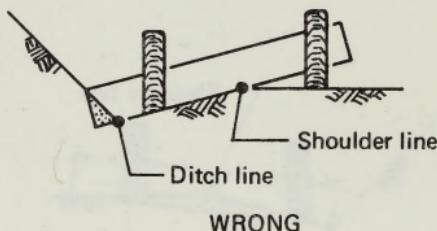
WRONG



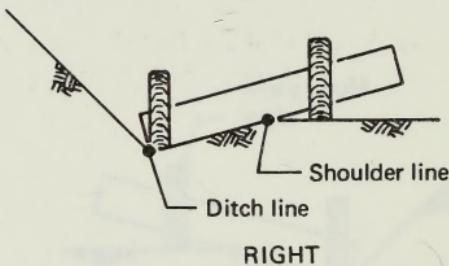
RIGHT

2. Undercutting the backslope is the easiest way to clean a ditch. However, within a short time the soil dries out and slides back into the ditch, making it look as though it had never been cleaned.

Tilting the blade back and running with the toe of the blade on the ditch line will correct the problem. Riding with the wheels in the ditch should keep the blade on the ditch line.



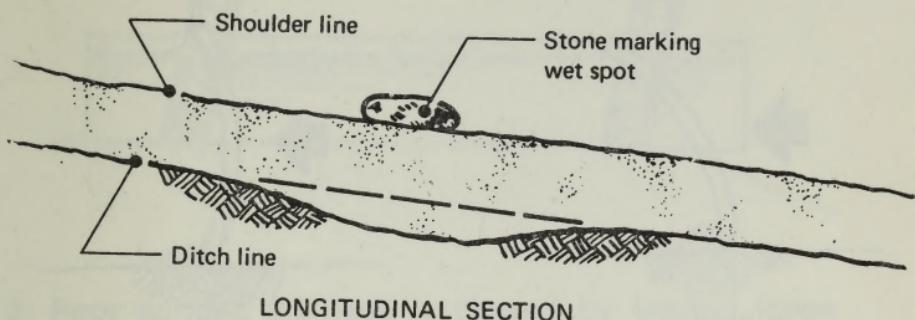
WRONG



RIGHT

3. Variations in the ditch line resulting in Ponding is caused when the operator ditches with the wheels in the ditch and is not watching the blade. When the wheels rise up on a high spot the blade will also rise; when the wheels drop the blade will dig deeper.

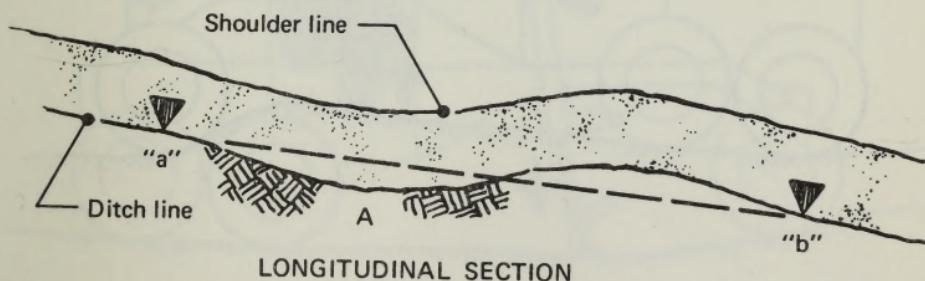
Before beginning the ditching operation check for ponds or wet areas. Mark these points for reference. Lifting blade slightly at low spots and digging a little deeper at high spots will correct much of the problem.



LONGITUDINAL SECTION

3a. Dips in road grade is a variation of the ditch ponding problem. When a downhill grade has a slight rise in it, a problem will occur in the ditch at the low point in the dip unless the water can drain away.

To allow water to flow by the dip (A), a new ditch line must be formed from "a" to "b", as illustrated.

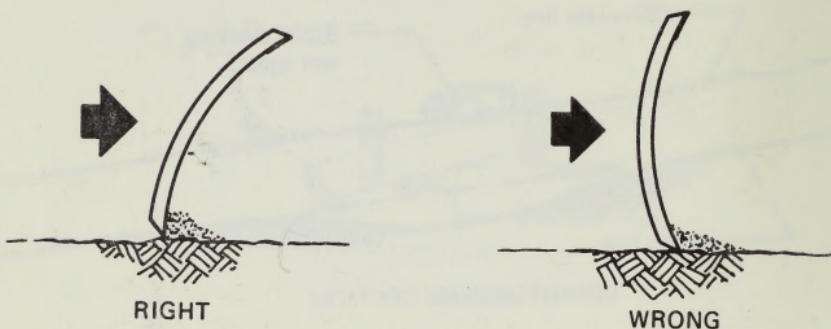


LONGITUDINAL SECTION

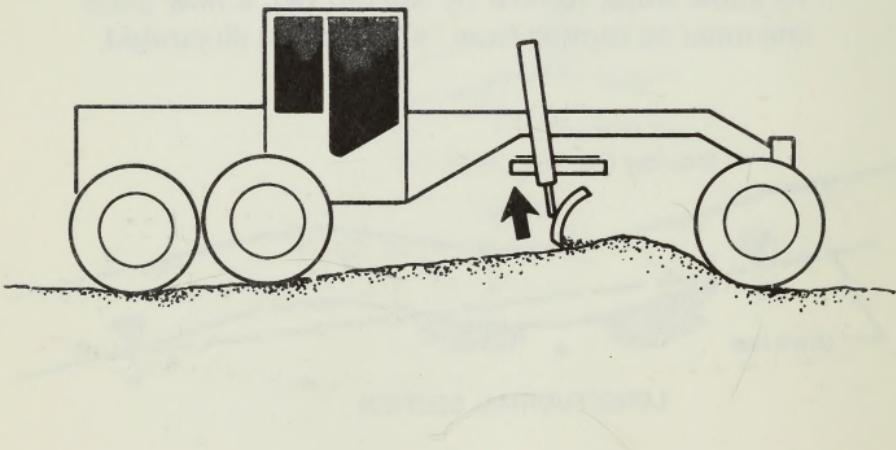
BLADING WITH A MOTOR PATROL CAN CAUSE TWO TYPES OF PROBLEMS:

1. Breaking the crust or the bond between the surface and the base can happen with incorrect blade cutting edge setting on the straight, incorrect blade height on hills or rises, and incorrect wheel angle on the curves.

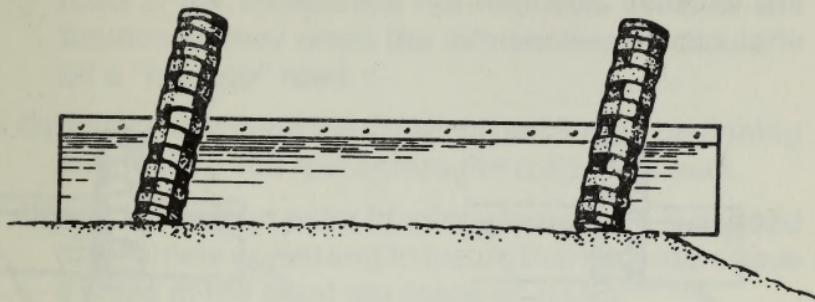
To avoid breaking up the surface, tilt the blade forward as illustrated.



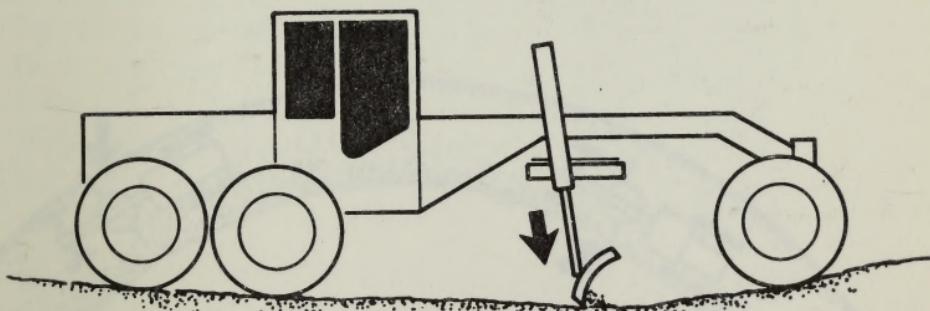
On a rise or a hill the blade must be raised to avoid cutting too deeply



On curves, to reduce the turning effort and make the curve shorter the front wheels should be leaned into the curve. Leaning the wheels will lower the frame so the blade must be raised to keep it from breaking the crust and to maintain a smooth uniform surface.

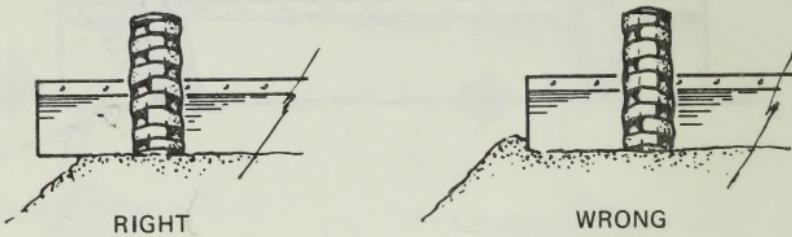


2. Poor surface drainage is caused by leaving loose material piled on the roadway. Either a double ditch is created, causing water to pond on the surface, leading to pot holes and a general breakup of the surface or material is left, which, through the forces of nature, can be moved into the ditch.

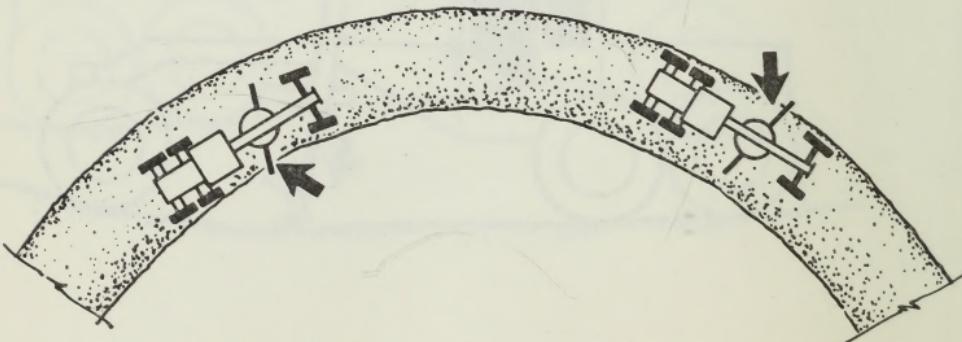


In dips the blade must be lowered to keep contact with the surface to remove loose material.

Along the outside edge of the roadway the blade should extend over the edge. On the lower edge of the cross slope this prevents the construction of the double ditch and on the upper section removes loose material which may, through wind and rains, be moved into the ditch.



To correct for "cutting the corner" on curves apply pressure to the toe of the blade if it is on the inside of the curve and to the heel of the blade if it is on the outside of the curve. This pressure will help skew the rear end of the motorgrader to aid the operator in making a sharper turn.



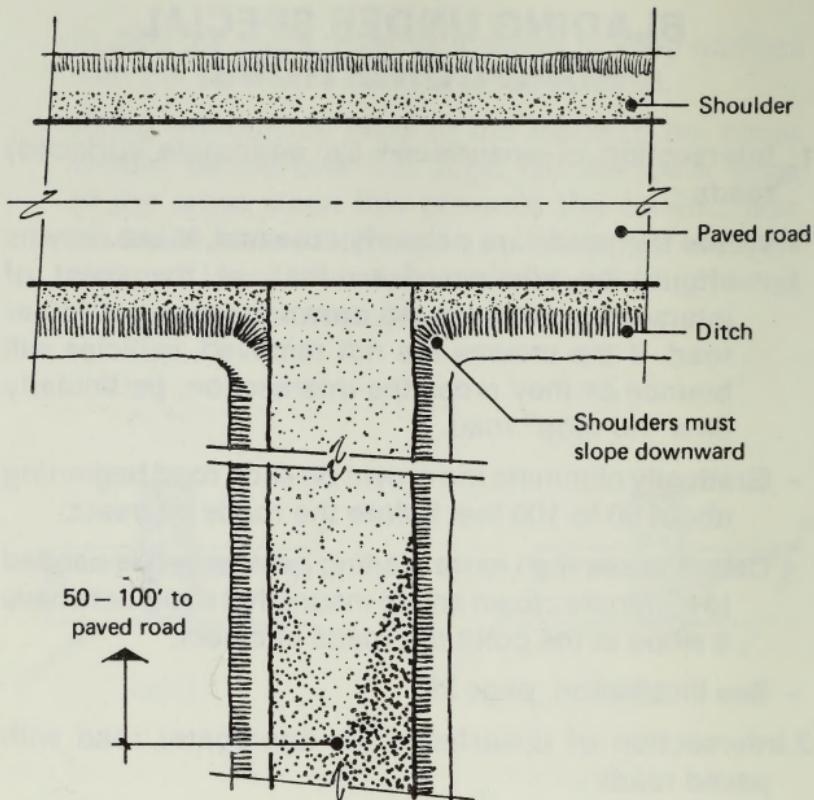
BLADING UNDER SPECIAL ROAD CONDITIONS:

1. Intersection of unsurfaced (or aggregate surfaced) roads -

- Where the roads are properly crowned, these crowns should be eliminated so that, at the point of intersection, there is no crown apparent in either road. If the crowns are not removed, vehicles will bounce as they cross the intersection, particularly on a "no-stop" road.
- Gradually eliminate the crown on each road beginning about 50 to 100 feet before the roads intersect.
- Check to see if an extra blading pass or two is needed to eliminate crown and to insure that shoulders have a slope at the point the roads intersect.
- See illustration, page 28.

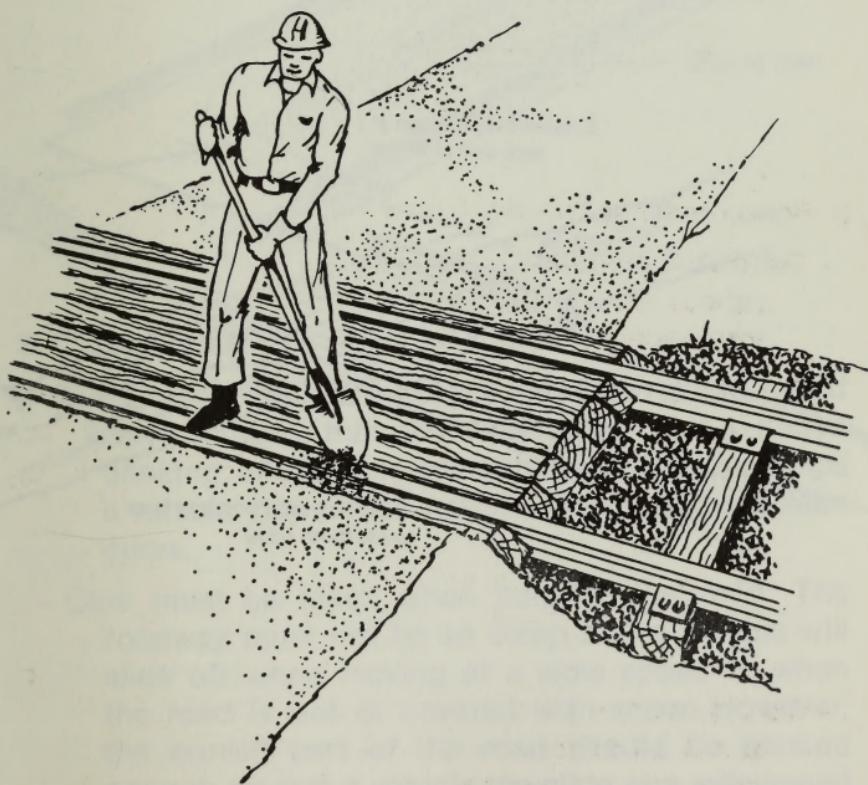
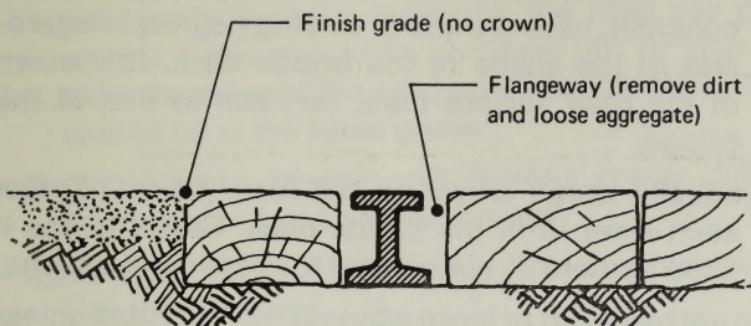
2. Intersection of unsurfaced (or aggregate) road with paved roads -

- Use same procedure as above to eliminate crown in the unpaved road. The unpaved road and the pavement must be at the same grade where they intersect.
- Do not blade dirt or loose aggregate onto the paved road. Pull onto pavement (watch for cross-traffic), drop blade, and remove any loose material using reverse motion.



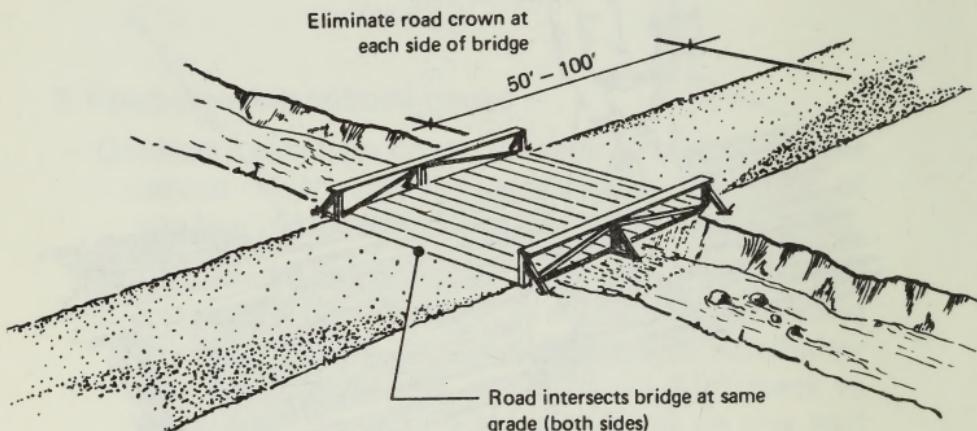
3. Road crossing railroad tracks -

- Gradually eliminate crown on each side of the tracks (about 50 to 100 feet) so that at the point of intersection, there is no crown in the road.
- Do not blade dirt or loose aggregate onto railroad tracks; it will get wedged in the flanges and could cause derailment. Always stop the motor patrol after blading on each side of the tracks and check to make sure there is no loose material on any part of the tracks or between tracks and steel flanges. If there is, use a broom or hand shovel to remove it.
- To maintain a good approach to crossings, check to see if an extra pass or two is needed to eliminate crown and to meet the grade at the railroad tracks.



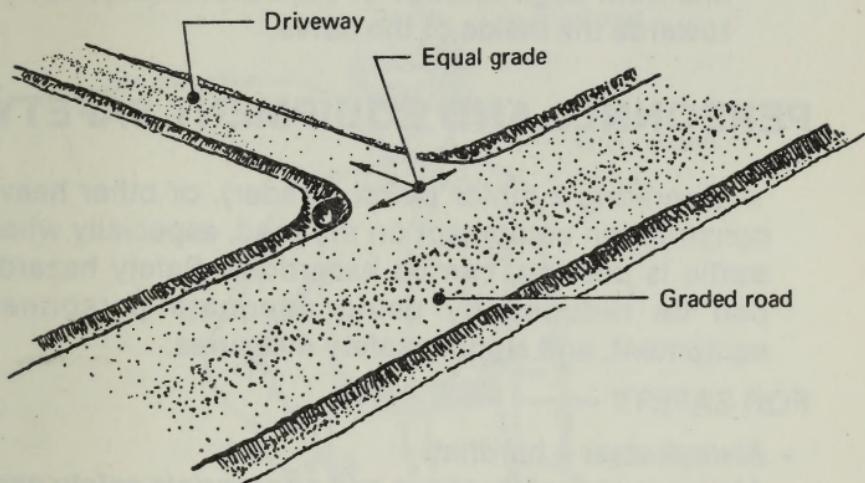
4. Road crossing bridge -

- Most wooden bridge decks do not have a crown; however, decks of most other bridges, particularly concrete, have crowns of varying degrees. Regardless of the shape of the bridge deck, the crown of the road surface must conform to that of the bridge.
- Gradually shape crown on the road (50 to 100 feet each side) to fit the bridge deck. Check to see if extra pass(es)** are needed to properly fit crowns.
- Do not blade dirt or loose aggregate onto bridge unless bridge is designed for such a cover; check with engineer.
- Do not let loose material build up on ends of bridge. Drive onto bridge, lower blade, and pull excess material off using reverse motion. This will also help smooth the approaches.



5. At driveways -

- When smoothing or reshaping a road that passes a driveway, attention must be given to the finished road surface grade. Although the road has preference, there should be no "drop off" or step up" from the edge of the road onto the driveway. They should be at the same grade.
- Do not "raise blade" and deposit loose dirt or aggregate in front of the driveway.
- Make extra passes, if necessary, to smooth entrance into the driveway.



6. Curved roads -

- On curved roads, the outside edge of the road (traveled way) is higher than the inside edge. This is called banking, or super elevating the road. Banking helps a vehicle stay on the road as it travels around the curve.
- Care must be taken when banking the road. The roadway must not be so steep that a vehicle will slide off when moving at a slow speed or when the road is wet or covered with snow. However, the curved part of the road should be banked enough so that a vehicle traveling at a safe speed around the curve will not pull to the shoulder on

the outside edge of the road. The steepness of super elevation will generally increase as the radius of the curve decreases.

- Change the road surface from a crown (50 to 100 feet on each side of curve) and back to crown - smoothly and gradually (use the crown gauge on motor patrol if available).
- At the mid-point of the curve, the outside edge of the road should be about the same elevation above the center of the road as the inside of the curve is below the center - in other words, practically a straight line from edge to-edge of the traveled way, tipped towards the inside of the curve.

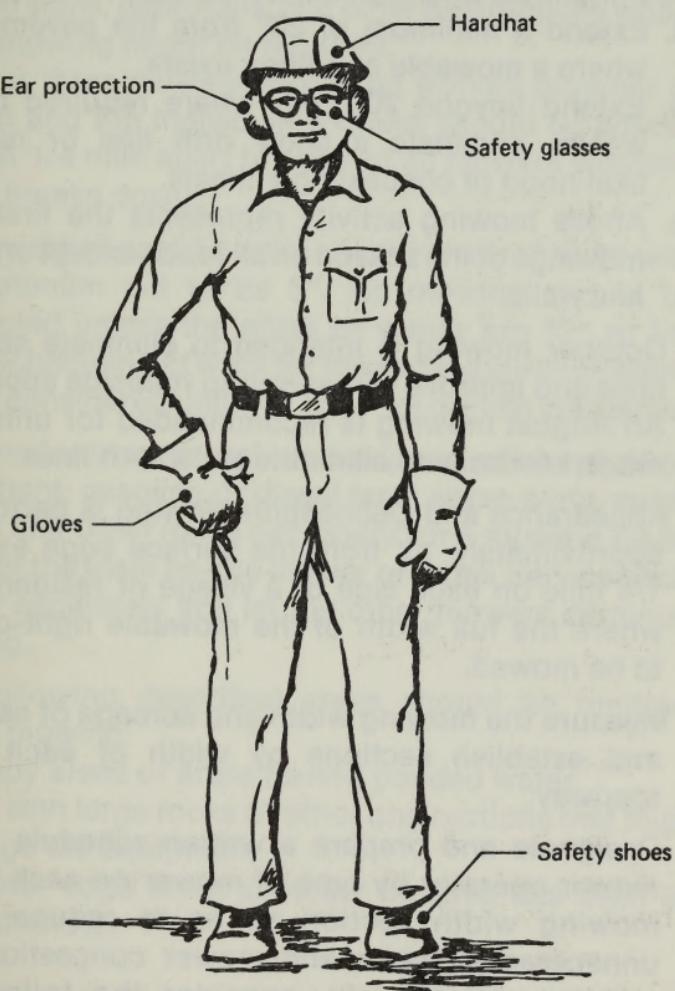
PERSONNEL AND EQUIPMENT SAFETY

- Operating a motor patrol (grader), or other heavy construction equipment on the road, especially when traffic is passing, can be hazardous. Safety hazards can be reduced by using adequate personnel, equipment, and signing safety measures.

FOR SAFETY -----

- Always wear a hardhat!
- Always wear safety shoes and appropriate safety gear on the job.
- Place red flagging on each end of the moldboard (blade) when blading.
- Have "Slow-Moving Vehicle" triangle on back of grader.
- Use flashing safety light on grader when in use.
- Turn headlights on when blading against traffic.
- Keep a visible fire extinguisher on grader at all times and make sure it is properly charged.
- Watch rear view mirror for traffic wanting to pass.
- Make sure there is a hand shovel (in good condition) on the grader
- When working downhill, put transmission in lower range for braking power.

- Always lower grader blade to the ground when equipment is not in use.
- Shift blade to center of grader and lock it when parking.
- Always remove ignition key when leaving grader unattended.
- Use proper signing and adequate flagmen where needed to warn traffic of work in progress or as a warning if equipment is left unattended.



MOWING - PAVED, GRAVEL AND EARTH ROADS

DESCRIPTION:

Machine mowing and hand mowing of grass and weeds.

PURPOSE:

To keep the roadside attractive, safe, and to assist drainage of roadbed and ditches.

PROCEDURES:

Suggested considerations:

1. Semi-annual and/or Annual Mowing:
 - a. Extend a minimum of 20" from the pavement edge, where a mowable condition exists.
 - b. Extend beyond 20" only where required to control weeds, eliminate a snow drift line or reduce the likelihood of concealing animals.
 - c. Above mowing activity represents the first and last mowings of the season on all roads except unimproved and trails.
2. October mowing is intended to eliminate snow drift lines and improve winter-spring roadside appearance. An August mowing is recommended for unimproved roads and trails to eliminate snow drift lines.
3. Appearance and Delineation Mowing is performed to approximately 10' from the surface edge except for 1/4 mile on each side of a village or residential area where the full width of the mowable right-of-way is to be mowed.
4. Measure the mowing width and acreage of each route and establish sections by width of each side of roadway.
5. Designate and prepare a written schedule for each mower operator by type of mower on each roadway mowing width section so as to reduce turning, unnecessary passes and mower congestion. When making assignments, consider the following: a.
Mowers over 8' in width should be used on the wider sections of roadside areas and scheduled for odd number of passes to avoid deadheading when moving

to the next section and to reduce the number of turn-arounds.

- b. Eight foot, seven foot, and five foot rotary mowers work best on wide shoulders and foreslopes and for cleaning around obstructions.
- c. Sickle bar mowers are basically non-productive and work best for cleaning up around obstructions, on narrow shoulders, "V" ditches, etc.
- d. Slope mowers are specialized equipment and should be used only when needed.
- e. Hand mowing should be held to a minimum and consideration given to the application of chemicals around signs, guardrails, and other obstructions where hand mowing might be required.
- f. Not over three mowers should be worked together as a team and the individual mowers should be spaced at least 1/4 mile apart to prevent all mowers stopping if one breaks down.

6. All mowers should be set no lower than 4" to 6" with the optimum cut to be 5". No mowing should be scheduled unless the grass or weeds are 12" to 14" high. Scheduling of work for the second cutting should not be considered until 12" to 14" of growth is attained.

7. Use a service truck or pick-up equipped with lubrication equipment, gasoline or diesel tank, spare parts, spare blades and other items necessary for a mowing team, whether the team be one mower or three. Service each mower separately and let the other mowers continue working.

8. The following described areas should be omitted during mowing:

- a. Swampy areas or areas having ponded water.
- b. Areas with large rocks or other obstructions that might damage the equipment.
- c. Shoulder edge when shoulder material has been left in a windrow.

LITTER PICKUP - PAVED, GRAVEL, OR EARTH ROADS

DESCRIPTION:

Annual, Semi-Annual or Quarterly as needed for removal by hand of litter and debris from the right-of-way.

PURPOSE:

The objective is to remove that which is either unsightly to the traveling public, potentially damaging to mowing equipment or an obstruction to drainage ways.

PROCEDURES:

1. 1st worker starts pickup at beginning of assigned area with litterbag.
2. 2nd worker drives ahead about 1000 feet or less, leaves truck and starts litter pickup.
3. When the first worker reaches the truck he loads or empties bag in truck and drives ahead 1000 feet or less, leaves the truck and starts litter pickup.
4. This leapfrog method continues the rest of day or until assigned area is covered.

TRAIL MAINTENANCE

TREACHEROUS TRAILS

This work involved removing trees which had fallen across the trail and which obstructed the trail.

To remove structures which are dangerous to the user, several major trees greater than 10 inches in diameter

REINFORCEMENT

When a trail becomes a trap, remove a segment that will ensure that the remainder of the trail will not encroach upon trails leading to the center of the trail. In addition, the remaining trail is reinforced with a series of logs to be called trail logs or logs of wood.

TREAD REPAIR - SLIDES

DESCRIPTION:

This work consists of removing minor slides or sluff which have encroached on the trail tread and repairing trail tread that has slipped downhill.

PURPOSE:

To correct all damage done by traffic or erosion.

PROCEDURES:

1. Determine equipment and manpower required to remove slides from trail tread or to repair areas where the trail tread has slipped downhill.
2. Reconstruct trail to original shape or with such additional outslope and grades as may be needed. Follow specifications for construction.
3. In areas where tread has been widened, check for additional drainage needs.

TREAD REPAIR - WINDFALL

DESCRIPTION:

This work consists of removing trees which have fallen over the trail and those in danger of falling.

PURPOSE:

To remove obstructions which are dangerous to the user of the trail and/or may prevent easy access along the designated route.

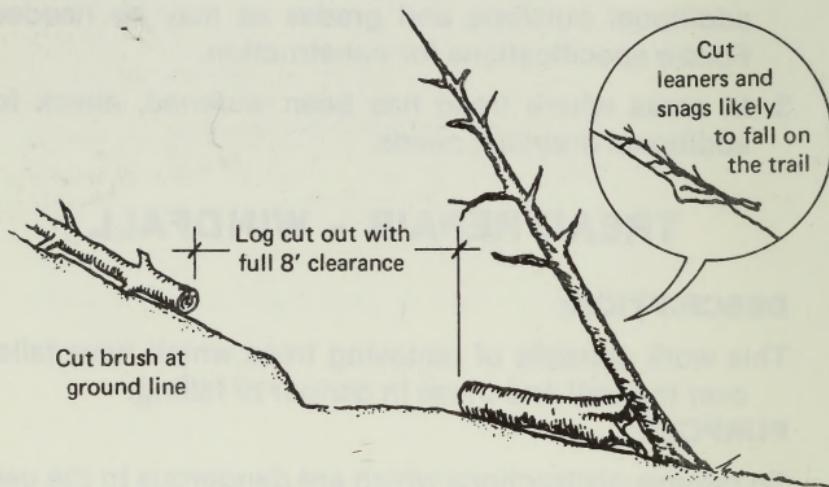
PROCEDURES:

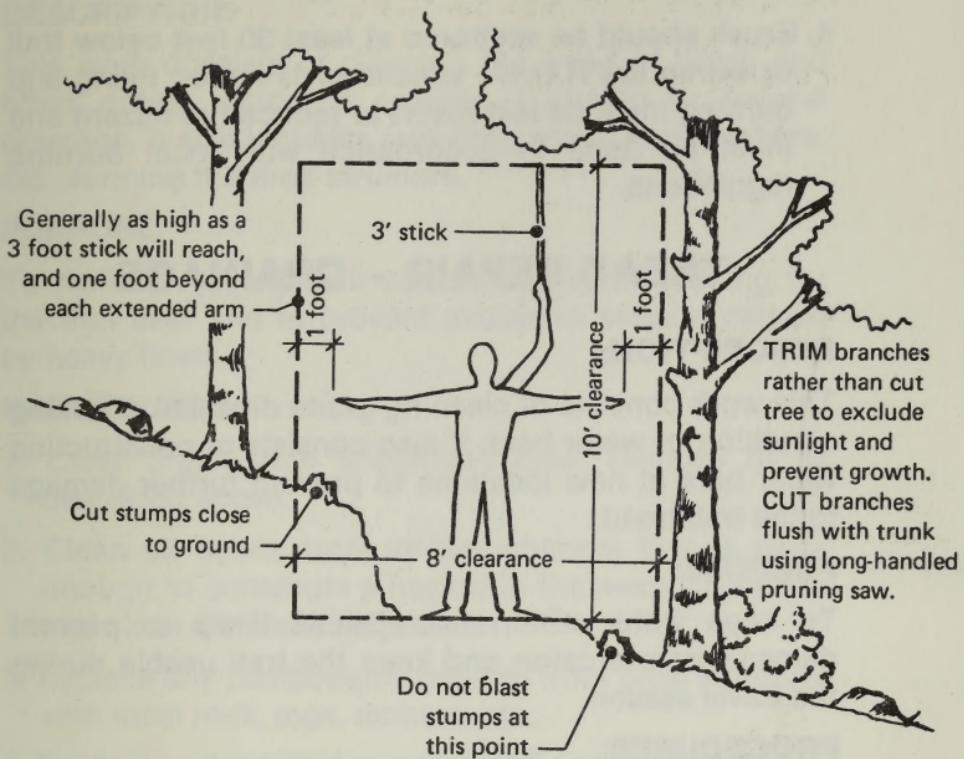
1. When trees fall across a trail, remove a section that will insure that the remainder of the log does not encroach closer than 4 feet to the center of the trail.
2. In cutting the log, make the cuts at a sufficient angle to permit the cut section to be rolled free with a minimum of effort.

3. Make the uphill cut first to permit the lower section to hold the upper position from sliding and injuring the workers. This also permits a check of the upper section after cutting to see if there is a tendency for it to slide into the trail.

4. Move all logs, that will roll, to a point below the trail or against standing trees to prevent them from later blocking the trail.

5. Clear the trail to limits shown on next page and deposit in a safe and acceptable manner within the rights-of-way.





TREAD REPAIR - BRUSH

DESCRIPTION:

This work consists of brush control, either by cutting or Chemical weed and brush control.

PURPOSE:

To keep the trail clear for users and to help reduce fire hazard.

PROCEDURES:

1. Cut all brush flush with ground to original clearing limit with hand tools or powered brush-cutting saws.
2. After cutting, sterilize the brush stumps to prevent sprouting. Use caution not to destroy plant growth outside the clearing limits.

3. In areas of heavy snowfall, brush less than 3 feet in height may be chemically treated.
4. Brush should be scattered at least 30 feet below trail or within the R.O.W., whichever is lesser. Piling and burning must be last resort to reduce fire hazard and must be done in accordance with local burning regulations.

TREAD REPAIR - DRAINAGE

DESCRIPTION:

This work consists of cleaning grade dips and checking condition of water bars; it also consists of constructing water bars at new locations to prevent further damage to the trail tread.

PURPOSE:

To keep water within manageable limits to prevent damage from erosion and keep the trail usable during the travel season.

PROCEDURES:

1. Check grade dips for conformance to original construction specifications or excessive damage caused by erosion. Grade dips are sections of trail where a shorter piece has been built with a grade slightly adverse the prevailing grade to of the trail and outsloped at the low point in the dip to divert water from the trail.

NOTE: Instead of building dips in an existing trail, it is better to construct waterbars.

2. Repair or replace waterbars as required.
3. Culverts should be carefully checked and cleaned as required.
4. Bridges should be carefully inspected and the required work done to standard construction specifications. Post safe load limits where applicable.

FORD REPAIR

DESCRIPTION:

This work consists of cleaning the tread of brush and other debris, where it crosses a stream or natural drainage. It also includes replacing rocks, logs, timbers, etc., forming the drop structure.

PURPOSE:

To maintain an efficient and safe stream crossing for the trail user and to prevent excessive erosion caused by heavy flows.

PROCEDURES:

1. Clear brush from immediate area. Dispose of as described above.
2. Clean all debris from stream channel that is close enough to constitute a hazard in the event of a flood and clean the trail of all debris.
3. Replace any components missing from drop structure with local rock, logs, timbers, etc.
4. Replace trail tread as required with local material.

GATES (CROSS FENCING)

DESCRIPTION:

This work consists of straightening braces, replacing fasteners, straightening bent gates and tightening cross fencing.

PURPOSE:

To maintain gates in such a condition that they will serve their intended purpose, and present a satisfactory appearance.

PROCEDURES:

No step-by-step procedure can be stated for minor structure maintenance. Each area of use or vandalism will have to be evaluated for parts, equipment and manpower required to repair or replace the damaged

structure. In most cases, BLM standard specifications and drawings are available and should be used where applicable.

SIGN REPAIR

DESCRIPTION:

This work consists of replacing signs, parts, and repairing wood routed signs as required.

PURPOSE:

To repair or replace damaged, defaced, or dirty signs that are a potential hazard, present a poor appearance, and are a discredit to the Bureau.

PROCEDURES:

All signs should be inspected at least once a year under daylight conditions and once every two years under nighttime conditions (if signs are reflective). Barriers should be inspected frequently and kept in good condition.

Maintenance of all Bureau signs should be in conformance with BLM Manual Section 9130; all traffic control signs with BLM Manual Section 9131 as well as the "Manual of Uniform Traffic Control Devices (MUTCD).

CORDUROY REPAIR

DESCRIPTION:

This work will generally be limited to camping and picnicking areas and log steps leading to streams.

PURPOSE:

To prevent serious injury to persons and pack or saddle stock.

PROCEDURES:

Inspect trail corduroy at least once each year to determine need for repair or replacement.

Replace logs to rebuild trail to original construction criteria where a more appropriate substitution cannot be used.

LITTER CLEANUP

DESCRIPTION:

This work shall consist of picking up and packaging litter along trail.

PURPOSE:

To remove that which is either unsightly to the user of the trail or an obstruction to drainage ways.

PROCEDURES:

Litter pickup will usually be done by persons on foot rather than motorized equipment.

Litter which is picked up and packaged should be hauled to an authorized disposal area.

ACKNOWLEDGEMENTS

- The Asphalt Handbook, Revised Edition, The Asphalt Institute, Manual Series No. 4.
- Specifications and Construction Methods for Asphalt Concrete and Other Plant-Mix Types, the Asphalt Institute, Spec. Series No. 1 (SS-1).
- Drainage of Asphalt Pavement Structures, The Asphalt Institute, Manual Series No. 15 (MS-15).
- Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects, U.S. Dept. of Transportation, FHWA (FP-79).
- Maintenance and Highway Safety Handbook, U.S. Dept. of Transportation, FHWA.
- Road and Trail Maintenance Standards, Bureau of Land Management, California.
- Road Maintenance Specifications, Bureau of Land Management, New Mexico.
- Standard Specifications, California Dept. of Transportation, Division of Highways.
- Handbook of Steel Drainage and Highway Construction Products, American Iron and Steel Institute.
- Suggestions for Temporary Erosion and Siltation Control Measures, U.S. Dept. of Transportation, FHWA.
- Highway Design and Operational Practices Related to Highway Safety, American Association of State Highway and Transportation Officials, AASHTO.
- Standard Specifications for Road and Bridge Construction, Colorado State Highway Dept.
- Blading Aggregate Surfaces, National Association of County Engineers.
- Guidelines for Erosion and Sediment Control Planning and Implementation, U.S. Environmental Protection Agency, Office of Research and Monitoring.
- Guide for Mountain Trail Development, U.S. Dept. of Agriculture, USFS.
- OSHA Safety and Health Standards, U.S. Dept. of Labor, Occupational Safety and Health Administration, OSHA 2207.
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